

Takasi YAMAZAKI*: **Embryological studies in Ebenales (1)**

山崎 敬*: カキノキ目の胚発生 (1)

The Ebenales includes 7 families; Sapotaceae, Ebenaceae, Styracaceae, Symplocaceae and three small families Sarcospermataceae, Lissocarpaceae and Hoplostigmataceae. These families distribute mostly in the tropical and subtropical regions of the world. They have received very little attention in the embryology, as it is difficult to collect the sufficient materials for investigation. I would like to report the embryology of *Styrax japonicus*, *Symplocos chinensis*, *Diospyros kaki* and *Pouteria obovata* for the purpose to solve the problem of relationship between these families.

Styracaceae

The general embryological studies in this family have been made by Manshard (1936) in *Styrax obassia* and Copeland (1938) in *Styrax californica*, and the embryogeny of *Styrax officinalis* by Veillet-Bartoszewska (1960). The embryology of *Styrax japonicus* is added in this paper. The material was collected from Kami-saginomiya, Nakano-ku, Tokyo Pref., and fixed in formalin-acetic-alcohol.

Ovule and embryo sac. The ovary is trilocular and has 2-4 anatropous ovules in each locule on an axile placenta (Fig. 3: a). The ovule is bitegmic and tenuinucellate. The inner integument consists of 5-7 cell layers containing dense cytoplasm and degenerates early. In mature embryo sac stage the inner integument becomes smaller and has the compressed dark coloured cells (Fig. 3: b and c). The outer integument is well developed markedly massive layers and completely covers the inner integument in mature embryo sac stage (Fig. 3: c). A single hypodermal archesporial cell differentiates in the young nucellus (Fig. 1: 1). The nucellus represented by a single layer of cells degenerates early. The archesporial cell

* Department of Botany, Faculty of Science, University of Tokyo, Tokyo. 東京大学理学部植物学教室.

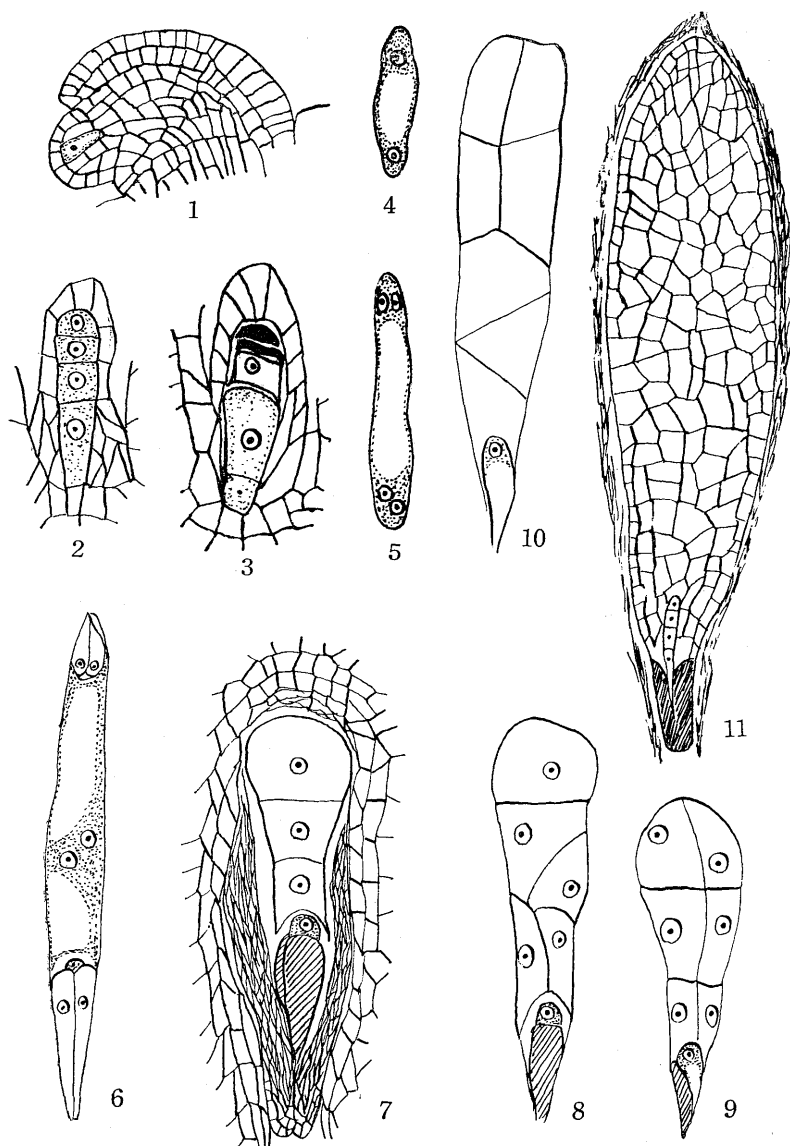


Fig. 1. *Styrax japonicus*. Stages in development of the embryo sac and endosperm.
1, $\times 200$. 2-6, $\times 300$. 7-10, $\times 150$. 11, $\times 50$.

functions directly as the megaspore mother cell and divides giving rise to a linear tetrad of four megaspores (Fig. 1: 2). The chalazal one functions and gives rise to the embryo sac (Fig. 1: 3). The functional megaspore undergoes three nucleal divisions leading to the formation two, four and eight-nucleate gametophyte (Fig. 1: 4 and 5). The mature embryo sac is filiform in shape and shows the usual organization (Fig. 1: 6). Three antipodal cells lie side by side or in a row and degenerate before the fertilization.

Formation of the endosperm. The endosperm is the cellular type. The first division of the primary endosperm nucleus takes place with a transverse wall to form a micropylar and a chalazal chambers. The second division in the chalazal cell is transverse and next longitudinal, while micropylar cell divides longitudinally (Fig. 1: 7-9). Subsequent divisions are irregular and all the cells divide and contribute to the endosperm formation (Fig. 1: 10-11). The mature endosperm is ellipsoidal body consisted of many cells containing no starch but much oil. The endospermal haustorium cannot be found anywhere.

Emblyogeny. After the fertilization, the zygote elongates, most of the cytoplasm remains near the tip of the elongated cell and the nucleus is also located in this position. The first division is transverse resulting in an apical cell *ca* and a basal *cb* (Fig. 2: 2). The basall cell *cb* undergoes a few transverse divisions and contributes to the formation of the suspensor *s*. The upper cell *ca* divides transversely to form the tiers *cc* and *cd* (Fig. 2: 3-4). The upper cell *cc* divides by vertical walls oriented at right angles each other to give rise to four cells. Transverse divisions in each of these four cells result two tiers of four cells each *l* and *l'* (Fig. 2: 5-9). Four cells of the upper tier *l* are divided by tangential walls to form outer and inner daughter cells (Fig. 2: 10). The outer daughter cells are divided only by anticlinal walls and give rise to the epidermal initials. The divisional sequence of the inner daughter cells is not definite, whether longitudinal followed by transverse or in the reverse order. Thus formed inner daughter cells of the tier *l* differentiate to be the mother cells of the cotyledonary initials exteriorly and the elements which constitute the stem apex interiorly (Fig. 2: 12-16). Four cells of the lower tier *l'* are divided by longitudinal walls to produce the outer and inner cell layers (Fig. 2: 10).

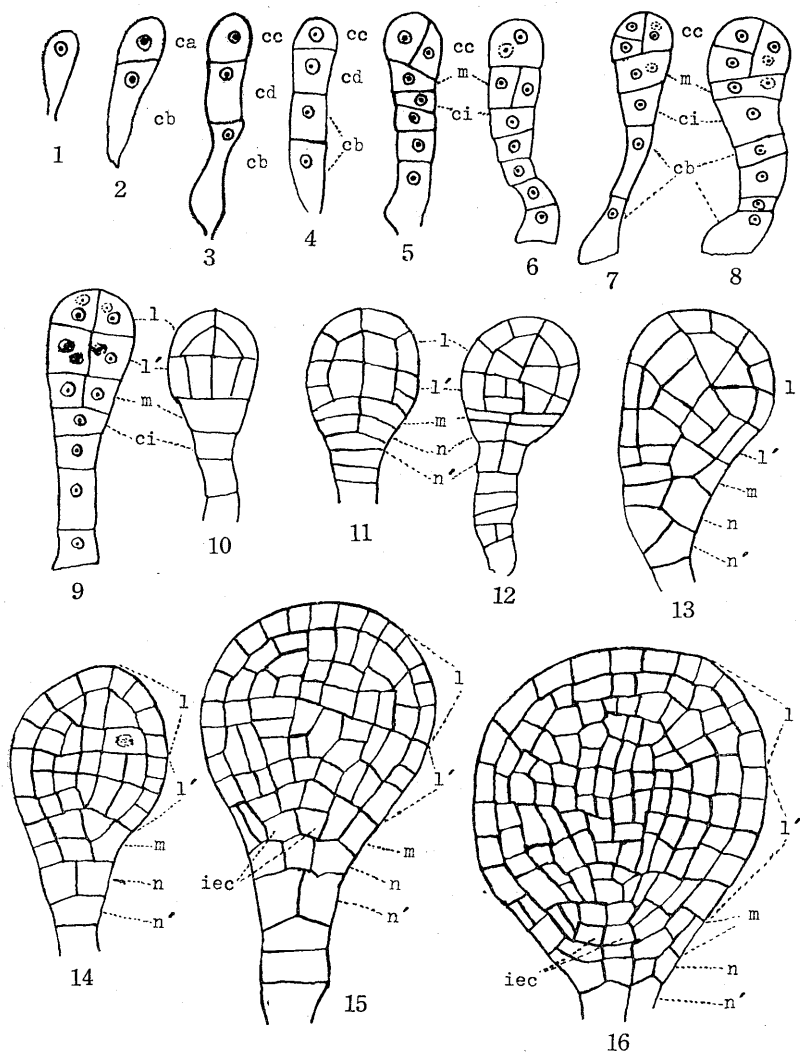


Fig. 2. *Styrax japonicus*. Stages in the embryo formation. 1-14, $\times 270$. 15-16, $\times 240$.

The resultant outer daughter cells of the tier l' repeatedly divide anticlinally and give rise to the epidermal initials, and the inner cells by continuous periclinal and anticlinal divisions form the plerome and periblem initials

(Fig. 2: 12-16).

The cell *cd* divides transversely to form two tiers *m* and *ci* (Fig. 2: 5). The tier *m* divides longitudinally to form two cells (Fig. 2: 6-9), and re-divides comparatively slowly to form the initials of the central cylinder of the hypocotyl *icc*, the initials of the root cortex *iec*, and the lateral part of the root cap *co* (Fig. 2: 13-16). The tier *ci* divides transversely to form

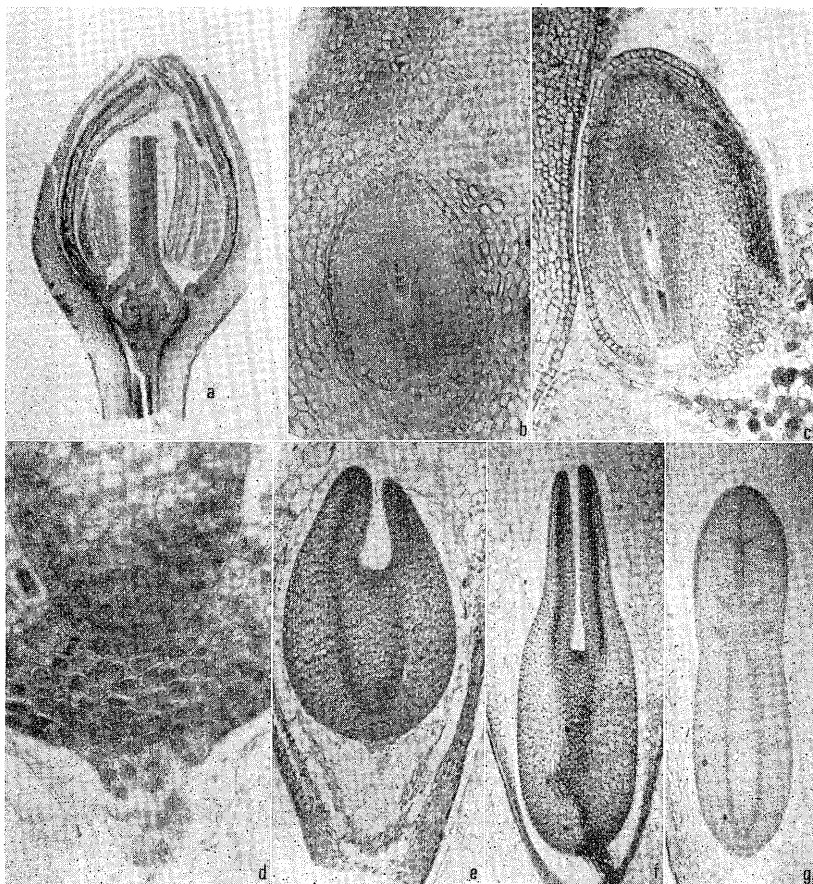


Fig. 3. *Styrax japonicus*. a. Longitudinal section of the young flower. $\times 12$. b. Ovule showing megaspore tetrad, the chalazal one functioned. $\times 150$. c. Ovule showing after the fertilization. $\times 150$. d. Young embryo showing initials of root cortex and central cylinder, same with fig. e. $\times 120$. e. Young embryo. $\times 45$. f. Young embryo. $\times 25$. g. Young embryo viewed at right angles with fig. f. $\times 25$.

the tiers n and n' (Fig. 2: 11). The upper cell n differentiates as the apical part of the root cap (Fig. 2: 15-16). The lower cell n' undergoes a few irregular divisions and contributes to the formation of the suspensor.

The process of the embryo formation of *Styrax japonicus* as follows:

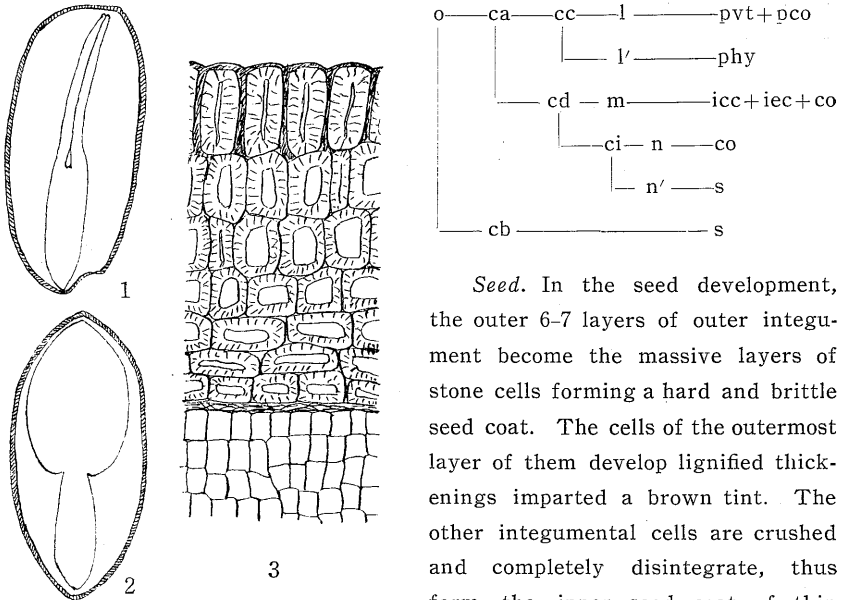


Fig. 4. *Styrax japonicus*. 1 and 2. Longitudinal sections of mature seed, side and front views. $\times 5$. 3. Seed coat. $\times 350$.

Seed. In the seed development, the outer 6-7 layers of outer integument become the massive layers of stone cells forming a hard and brittle seed coat. The cells of the outermost layer of them develop lignified thickenings imparted a brown tint. The other integumental cells are crushed and completely disintegrate, thus form the inner seed coat of thin membrane. The endosperm occupies the entire seed cavity, consists of thin walled cells. The large embryo

lies in a plane at parallel to the plane of symmetry of the seed, comprises two large cotyledons and a massive hypocotyl.

Literatures

- Manshard, E., Embryologische Untersuchungen an *Styrax obassia* Sieb. et Zucc. *Planta* 25: 364-383 (1936) Copeland, H.F., The *Styrax* of Northern California and the relationships of the Styracaceae. *Amer. J. Bot.* 25: 771-780 (1938) Veillet-Bartoszewska, M., Embryogénie des Styracacées. Développement de l'embryon chez le *Styrax officinalis* L. *Comptes rendus Acad. Sci. Paris* 250: 905-907 (1960).

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カキノキ目 Ebenales は大きな科としてアカテツ科 Sapotaceae, カキノキ科 Ebenaceae, エゴノキ科 Styracaceae, ハイノキ科 Symplocaceae の4科があり, また Sarcospermataceae, Lissocarpaceae, Hoplostigmataceae の,それぞれマレーシア, 南アメリカ, アフリカの小地域にのみ分布する科がある。これに属する種類の大部分は熱帯, 亜熱帯に分布していて, 生の材料を入手することが困難なため, 胚発生の研究はきわめて不完全である。日本にはエゴノキ, サワフタギ, カキノキなど身近に材料があり, アカテツは小笠原から不十分ながら材料を入手したので, 胚発生を中心に各科の相互関係, カキノキ目の系統関係を明らかにしたいと思う。

エゴノキ *Styrax japonicus* の胚珠は倒生で2枚の珠皮をもつ。内珠皮は胚珠形成の初期によく発達しているが, 2核胚嚢期の頃から退化しはじめ, 胚嚢が成熟する頃は細胞が萎縮して, よく発達した外珠皮に包まれてしまう。胚嚢のできかたは普通型である。胚乳形成は cellular type で細胞分裂のしかたはかなり不規則である。胚形成は m 層から幼根の原皮層と原中心柱との起源細胞が分化する。この様式は Chenopodiad type とよばれる分化のしかたにほぼ一致し, ツツジ目の胚形成とかなり類似する。成熟した種子は堅い石細胞からなる数層の表皮をもつ。種子には多量の胚乳があるが澱粉をもたず油を含むなどの特徴がある。

○硫黄島に帰化したイネ科植物キヌゲガヤ (津山 尚) Takasi TUYAMA: *Tricholaena repens*, a grass naturalized on Iwo-jima (Volcano group).

1969年7月, 中硫黄島に上陸して戦前, 戦後の植生の変化を観察して来た。この島の元山とパイプ山をつなぐ平坦地は20数年を経て大きく隆起し, 地熱も一般に低下したためか, 千鳥ヶ浜と称せられた平坦地は大部分がイネ科でおおわれていたのには一驚した。この中で一番目立ったのが *Tricholaena repens* で高さは50—70 cm 位, 小穂にはじめ著しい紅紫色の毛があり, これが後に白色の絹毛状の毛に変わる。アフリカ Natal 原産であるが, 多分ハワイ島を経由してこの地に繁殖をはじめたもので, 典型的な戦時移入植物と考えられる。ハワイにも多少見られるが, 硫黄島の乾燥した地帯に適したものか, 著しく繁殖している。小穂の毛の状態からキヌゲガヤと呼称することとしたい。ハワイでは乾燥花としても用いられる由であるが, 今のところ小笠原島には入っていない。いづれ日本の暖地にも侵入して来るであろう。附図を参照されたい。或は沖縄にも既に入ってきているのではないかと思う。

小穂は非常に多毛で, 解剖しないでは, 構造が全く分らない。小穂の最下部には苞(苞穎)があるが, 非常に小形で, 殆んど毛のみからなり, 数花の例では一個しか発見